EASY OPEN WATER SOLUBLE BLISTER PACKAGE.

This invention relates to an easy open package particularly blister type packages for products which can withstand being wet.

Background to the invention

Most manufactured products are presented for sale in packages. The packaging material usually of paper paperboard and/or plastics needs to be printable and also to protect the articles. For personal hygiene products the articles usually are sealed to ensure the hygiene standards for the product. Consumers usually like to be able to see what they are purchasing so that it is common for at least part of the packaging material to be transparent. Blister packs where a transparent thermoformed polymer layer is bonded to a paper or card board backing is a common packaging method for products of this type.

Tooth brushes are commonly enclosed in a blister pack of transparent thermoformed plastic material enclosing the brush with a paper or paperboard panel at the back. The packaging of tooth brushes has been the subject of a number of patents. USA patent 4588089 discloses a disposable brush and paste package. USA patent 4890732 discloses a package for a handle and disposable brush heads. USA application2003/0012594 discloses a disposable brush with paste adhered to the handle. None of these patents address the problem of easy opening the packages to access the product.

Blister packages can be difficult to open as the materials used do not tear easily and it is often necessary to use scissors to open the package. The package then has to be disposed of and packaging of this sort adds to the environmental burden of waste disposal because the materials are not readily biodegradable.

Other articles are packaged in a similar fashion and present similar difficulties in opening and the disposing of the packaging material.

Soluble packages have been proposed for chemical or food products that need to be dispersed or mixed with water. USA patents 5827586 and 6484879 are examples of water soluble packaging for water dispersible agrichemicals. Patent application WO02/077354 discloses a water soluble package for laundry detergent. WO03/016165 discloses a water soluble controlled release package.

Japanese abstract 09124804 discloses a hot water soluble wrapping for raw meat. None of the films disclosed in these patents are useful in blister packaging and only some are fully biodegradable.

It is an object of this invention to provide an easily opened package that is also easily disposed of in an environmentally responsible fashion.

Brief description of the invention

To this end the present invention provides a product and package combination in which a significant portion of the package is sufficiently water soluble that the portion of the package can be disintegrated by exposure to water to allow the package to be easily opened.

This package combination may be applied to any product but especially to products that are usually opened in the vicinity of water such as cleaning utensils, garden utensils and some food stuffs such as vegetables.

A tooth brush enclosed in a water soluble packaging material may be opened by placing it under water or a running tap or faucet so that the packaging material is disintegrated, exposing the tooth brush ready for use.

The packaging material is preferably composed of a thermoformed transparent water soluble polymer composition preferably alone or with a paper or other material for the rear of the package, that is easily disintegrated by contact with water and biodegrades in waste water systems. Such polymers may be water soluble starch or modified starch polymers , soluble polyesters or polyvinyl alcohol or blends of these polymers with natural polymers such as starch or modified starch.

The advantage of this invention is that the product is easily released from its packaging and at the same time is instantly disposed of as a waste water effluent. In the case of a tooth brush the consumer usually opens the package in front of a basin and would turn on the tap or faucet to use the brush. Thus the combination provides two significant benefits.

Not all biodegradable materials are water soluble so that prior art packages made from biodegradable materials could not be opened by the action of water and would have to be disposed of as solid house hold waste.

The packaging method that is most suitable for use in this invention is blister packaging consisting of a backing or top sheet and a thermoformed blister adhered to the backing. In a preferred form of this inventuion the adhesion between the backing sheet and the blister is achieved by wetting the blister with water and preferably applying pressure to achieve adhesion.

The preferred water soluble polymers are those based on starch or modified starch alone or blended with other water soluble synthetic polymers such as water soluble grades of polyvinyl alcohol.

A preferred biodegradable polymer has the composition

a) from 8 to 95% by weight of a modified starch preferably starch modified to include an hydroxyalkyl C_{2-6} group or modified by reaction with an anhydride of a dicarboxylic acid
b) from 0 to 80% of starch
c) from 0.5 to 20% by weight of a water soluble polymer selected from polyesters, polyvinylacetate, polyvinyl alcohol and copolymers of ethylene and vinylalcohol which have a melting point compatible with the molten state of the starch components and optionally
d) from 0 to 20% by weight of a polyol plasticiser
e) from 0.1 to 1.5 % by weight of a C_{12-22} fatty acid or salt and
f) from 0 to 15 % by weight of added water.

The composition defined include formulations suitable for forming films or thermoforming rigid products such as transparent blister packs. The extruded sheet can be thermoformed into blister packs for use as biodegradable packaging. Usually the need to vent the extruder to remove water prior to the product exiting the extrusion die is not needed with these formulations.

Other processing methods may be used including injection moulding, extruded shapes including tubes, cast films for wraps and thermoformed sheet.

The modified starch contributes structural benefits to the resulting material. A preferred component is hydroxypropylated amylose. Other substituents can be hydroxyethyl or hydroxybutyl to form hydroxyether substitutions, or anhydrides such as maleic phthalic or octenyl succinic anhydride can be used to produce ester derivatives. The degree of substitution[the average number of hydroxyl

groups in a unit that are substituted] is preferably 0.05 to 2.The preferred starch is a high amylose maize starch. A preferred component is a hydroxypropylated high amylose starch A939 marketed by Penford Australia.

The other starch component is any commercially available starch. Dependent on the mechanical and optical properties required, a preferred concentration range for starch is 50 to 70.6%. This may be derived from wheat, maize, potato, rice, oat, arrowroot, and pea sources. Generally the water content is about 8 to 15 %.

The polymer component c) of the composition is preferably compatible with starch, water soluble, biodegradable and has a low melting point compatible with the processing temperatures for starch. Polyvinyl alcohol is the preferred polymer but polymers of ethylene-vinyl alcohol, ethylene vinyl acetate or blends with polyvinyl alcohol may be used. A preferred concentration range for sheet material is 7 to 9%.

The preferred plasticiser is a polyol particularly glycerol although ethylene glycol and diethylene glycol are also suitable as is sorbitol. Cost and for some products food contact, are important considerations in choosing the appropriate plasticizer. For low humidity environments it has been found that lower plasticizer content improves the toughness and long term resilience of the material. This is partly due to the properties of the starch ether component and the fact that at low humidity plasticizers such as glycerol tend to remove water from the starch polymer and make it more brittle. It is possible to process the formulation with no plasticizer and the rigid polymer formed is flexible and has good impact resistance at low humidity. When the plasticiser content is low additional water is added to improve processing. Thus the plasticizer content is preferably 0 to 15% and the water content is 15 to 0%. For film processing the plasticizer content is preferably higher than for rigid sheet products. Higher concentrations of plasticiser improve flexibility and for flexible packaging films or other thin films the preferred plasticiser content is 10 to 16%.

The fatty acid or fatty acid salt component is preferably present in concentrations of 0.4 to 1%. Stearic acid is the preferred component. Sodium and potassium salts of stearic acid can also be used. Again cost can be a factor in the choice of this component but lauric, myristic, palmitic, linoleic and behenic acids are all suitable.

It is found that the acid tends to accumulate near to the surface of the composition as it is extruded.

Detailed description of the invention

A preferred embodiment of the invention will be described with reference to the drawings in which

Figure 1 is a side view of blister package to which this invention is applied.

Figures 2 and 3 illustrate one method of forming a blister pack according to this invention.

The package as shown consists of a thermo formed product tray 12 boded at the peripheral sealing edges 13 to a backing material 11. The backing material 11 is often of card board or paper while the blister 12 is a transparent thermoformed tray of water soluble material. The backing 11 may also be formed from the same material as the blister tray 12. To facilitate easy opening only a portion of the tray or backing need be water soluble. For example the area 14 may be formed of water soluble material and the remainder of the package could be water insoluble. The water soluble portion 14 is large enough to allow easy access to the contents once the film is dissolved away. Such a water soluble portion can be created by forming the tray from a laminate having an inner water soluble layer and an outer water insoluble layer with a hole at area 14 exposing the water soluble inner layer. The blister material is preferably formed from a thermo formable starch polymer composition of the formula

A939 %	PVOH %	Stearic acid %	Water %	Glycerol %
81.5	8	0.5	10	0

A 939 is an hydroxypropylated high amylose starch marketed by Penford Australia.

An alternative and cheaper formulation is to replace 50% of the A939 with wheat starch.

Processing conditions depend on the formulations and the desired properties of the product to be produced. The materials need to be heated above 130 °C in the extruder to fully gelatinise the starches. The die temperature needs to be controlled below 110 °C to avoid foaming.

The preferred method of carrying out this invention involves mixing the starch, modified starch, vinylalcohol polymer lubricant and fatty acid components into a free flowing powder. The premixing can be carried out in any conventional mixer. The powder is then introduced into a screw extruder and subjected to an elevated temperature by the shearing action of the screw and the application of external heat to the barrel. The temperature equilibrates to an adiabatic profile ranging 40°C to 150 °C. Any liquid components including additional water are introduced by liquid injection or in the premix. The melt that is formed is then propelled toward the die where the temperature is reduced to a value in the range of 65 °C to 105°C.

A typical extrusion for rigid products in a single stage process has the following parameters:

Temperature profile °C: 60, 70, 90, 110,130, 145, 130, 120, 110

Screw Speed: 120 rpm

In a two-stage process, where compounding and sheet forming are separated, the compounding processing conditions are typically:

Temperature profile °C: 50, 50, 65, 130,130, 90, 65

Screw Speed: 150 rpm

And sheet forming occurs in a single screw extruder with

Temperature profile °C: 50,90,130,115

Screw speed: 150 rpm

Sheet ranging from 10micron to 800 micron can be extruded on a cast sheet line. Cooling and drying of the sheet in between the various rolls of the haul off line, is required to achieve the final moisture content of the sheet prior to wind-up, such as to avoid blocking and shrinkage on the wind-up roll. If the film is formed by the blown tube method some form of drying is also used. Talc may also be entrained in the air stream to reduce blocking of the film.

The films and thermoformed plastics of this invention are transparent and printable and are ideally suited as packaging items that need to be seen within the package. The sheets can be produced in any colour and normal printing processes are able to be used.

Table 1 sets out the optical properties of sheet formed from the preferred water soluble polymer of this invention.

Table 1

Property	Value	Comment
Gloss[1]	95%	measured at 60deg
Haze[2]	15%	Typical 20-30
Transmittance[3]	91%	Typical 84-90

All material conditioned 24hrs, 23°C, 50% RH

1 ASTM D2457-97 test method
2 ASTM D1003-00 test method
3 ASTM D1746-92 test method

The preferred compositions used in this invention are cold sealable and heat sealable. If transparency is not desired the package can be made non transparent. The preferred compositions are not sticky and have no offensive odour on dissolving in water.

Blisters can be made on standard thermoforming equipment. When thermoforming the polymer formulations described above the most important aspect is to use contact heating as compared to the more traditional radiant heating.

For pressure forming the general conditions are:

Heat temp. 130-160°C
Heat time 0.5-1 sec
Form time 1-1.5sec

These vary depending on conditions, mould shape, material gauge etc.

The water soluble polymers of this invention are used in blister packaging because:

- It is a convenient way to display and present goods
- It is tamper evident
- It aggregates small goods which reduces pilfering and makes economic quantities
- It allows for labels and POS that wouldn't be available on the good/product
- It protects goods from environment

A key problem for many packaging types including blisters is that they are too hard to open for many consumers. This has led to the advent of "packet rage" – irrational anger at the difficultly of getting into goods.

From an environmental perspective blisters are usually not recyclable. This is because a) the blister is made of many types of plastic which are hard to separate economically, b) the backing card is coated with a lacquer to allow the blister to stick making it unrecyclable and c) the blister and card are rarely fully separated. Cards for blister pack backing are usually coated with a polyacrylate lacquer designed to bond with thermoplastics such as PVC and PET.

For attaching the polymer of this invention to a backing card an acrylic polymer that either contains starch or that is polar is used. An example is Joncryl 624AU from Rhodia. This can be applied in the usual way as a printing process. The use of this type of lacquer means the package of this invention is fully biodegradable.

A surprising aspect of this invention is the effect of water on the blister as an attachment option. Water may be used as an adhesive to simplify the attachment process and make it significantly more economically and environmentally friendly. This method is illustrated in figures 2 and 3 of the drawings. A thermoformed blister 17 made from the polymer described above is filled with product 18 and the water is applied to the sealing flange 19 of the blister via an applicator 22 which may be a sponge or even a shot of water mist. Warm water or steam is also suitable. The amount of water needs to be sufficient to wet the flange surface 19 but not to warp or weaken it. The backing sheet 16 which may be paper card or the same polymer as the blister is then applied to the flange 19 and pressed by a plate 24 to complete the sealing and adhesion of the sheet 16 to blister 17. The pressure can be applied by a pneumatic or hydraulic cylinder. The contact time sufficient to effect bonding is about 5 seconds.

A clear printed coating can be applied to make most of the pack water proof allowing for just a patch to be easy to open. This can be a benefit where the product needs to be opened from a particular place or perhaps where a product may be release as a dose through a hole/orifice. Alternatively the waterproof section may be over a part of the product that needs to be protected. Because this

water barrier can be added as either a printing process or as a spray in a post process there is high flexibility in product design.

Example

A blister pack of a toothbrush was formed using the polymer described above as a blister attached to a card packing.

A commercial toothbrush pack was used as a comparative measured example.

The force required to peel open the commercial product was	2.415 N
The force required to peel open the blister pack of this invention	3.180 N
The force required to break the commercial product was	0.226 KN
The force required to break the blister pack of this invention was	0.115 KN
The force required to break the blister pack of this invention after wetting was	0.001 KN

Effectively no force was required to open the blister pack of this invention once it was wet.

Those skilled in the art will realize that this invention may be implemented in a variety of ways without departing from the essential teachings of the invention.